MICROSCOPY.

Professor Butschli's Experimental Imitation of Protoplasmic Movement.[1]—Professor Bütschli, of Heidelberg, has recently made some extremely interesting observations upon a substance which simulates in a remarkable way the appearance and movements of protoplasm of an Amoeba, or of the plasmodium of Mycotozoa. He has been kind enough to send to me some oil in a suitable condition for use, with directions as to the exact details of the experiment. In my laboratory, by following his directions, the movements described by him have been observed in a satisfactory manner. In order to obtain the best results some experience and care is requisite, and probably cannot always be obtained by a single experiment. The subject is so interesting, and so fitted for further investigation by all who have leisure and taste for the study of the vital phenomena of the Protozoa, and of living protoplasm in general, that I think it will be of advantage to the readers of this journal to have Professor Bütschli's directions, which he has permitted me to publish, placed in their hands.—E. RAY LANKESTER.

March, 1890.

HEIDELBERG, February 1st, 1890.

You have kindly asked me how I prepared the protoplasma-like drops which I have described. As you yourself feel greatly interested in this discovery, and presumably a like interest exists among other English biologists and microscopists, I hasten to satisfy your desire, and to explain somewhat more fully the methods which I have described in a previous publication.

As you well know already, I use in the preparation of these globules,—showing protoplasma-like streaming,—ordinary olive oil. My first experiments were made with a small quantity of olive oil, which had been standing for a long time in my laboratory in a small bottle. By some happy chance this oil had just the right properties which are necessary for the success of the experiment, for not every sort of oil is suitable. As far as my experience goes it tends to show that the ordinary oil cannot be directly used, because it is too thin, or is perhaps deficient in other qualities on which the success of the experiment depends. In order, therefore, to prepare a suitable oil, I proceed in the following manner: A medium-sized watch-glass, or flat dish, is

[1] From the *Quarterly Journal of Microscopical Science*, Vol. XXXI. April, 1890.

filled with a thin layer of common olive oil, and is placed on a water-bath or in a small cupboard, such as are used for imbedding in paraffine, at a temperature of about 50° C. Under the influence of the higher temperature the oil gradually loses its yellow color and becomes thicker. The great point now is to select the right moment at which the oil will have attained the proper degree of thickness and viscosity, as also the other properties, which at present I am not able to define more exactly, but on which much of the success seems to depend. The exact moment can, however, only be found out by systematic trials. After the oil has been thickening for three or four days, a tria should be made with a drop of it in the manner described below Should the drop not become finely vesiculate, and exhibit little or no streaming, continue the heating process, and experiment again on the following day. If the oil should become too thick it will form good, frothy drops, but will scarcely show any streaming. In this case mix it with a small quantity of ordinary olive oil, and thus render it more liquid. If it has become much too thick it will form a good froth, but the latter dissolves very rapidly in glycerine.

You see that the process to obtain the suitable oil is somewhat slow but I do not at present know of any other method by which the resule can be reached more quickly and surely.

To prepare the vesiculate drops I proceed in the following way: — In a small agate mortar I grind a small quantity of pure dry carbonate of potash (K_2CO_3) to a fine powder. I then breath on the salt till it becomes slightly moist, and with a glass rod add to it a drop of oil, mixing the two constituents to a thickish paste. The success of the experiment depends, however, more upon the nature of the oil than upon the proportion of the oil and salt in this mixture. Then, with a glass rod or a needle, I place a few drops of the paste, about the size of a pin's head or smaller, on a cover glass, the corners of which are supported by small pegs of soft paraffine. I then place on a slide a drop of water, and put the cover-glass over this in such a manner that the drops of paste are immersed in the water, but are not much compressed, to which end the corners of the cover-glass have been supported by the paraffine. The preparation is then placed in a deep chamber, and remains there about twenty-four hours. The preparation is then washed out with water by applying blotting-paper to one edge of the cover-glass, and supplying water at the other edge from a capillary tube.

If the drops have turned out well, they will begin almost immediately after this to move about rapidly, and change their shape continuously. The water under the cover-glass must now be displaced by glycerine,

diluted with an equal bulk of water, and the drops will then exhibit a vigorous streaming and forward movement, becoming gradually transparent. The amœboid movements are generally more distinct if the drops are somewhat compressed. If the drops do not show the streaming movement you may succeed in producing it by tapping the cover-glass slightly, by applying gentle pressure, or sometimes by breaking up the drops. For it seems as if at times incrustations were formed on the surface of the drops which prevent or impede the streaming movement, and which can, in part at least, be removed by the above-mentioned manipulations.

It is especially interesting to see how fast and beautifully the drops creep to and fro in water, or in half-diluted glycerine, even when they are not compressed. The streaming movement, on the other hand, is better seen if the drops are compressed, which may be done by inserting under the cover-glass a piece of broken cover-glass of medium thickness, and then removing the paraffine pegs. Then draw away the liquid until the necessary pressure is obtained. This streaming movement is better demonstrated twenty-four hours after the addition of the glycerine, as the drops will then be thoroughly cleared and transparent. Further, it is interesting to note that a progression of the drops takes place in the direction in which the streaming moves.

As this forward movement is rather slow in compressed drops, it is necessary to use a micrometer ocular to satisfy one's self of the advance.

Unfortunately the oils which I have prepared since my first experiments do not move and stream so well or so rapidly as those I employed then. The movement and streaming show themselves much more markedly and distinctly if they are examined on a warmed stage at a temperature of 50° C. If you should be in a position at your demonstrations to conduct the experiment at this temperature, the phenomena will certainly be much more evident.

From the preceding description you will see that it will be necessary, to obtain good results, to gradually get hold of the methods, and you must not doubt the correctness of the phenomena which I have described if the first trials do not give the desired results.

At all events, you will have at first to make some experiments so as to obtain an insight into the conditions and sort of phenomena, but I do not doubt that you will succeed in observing the appearances and in demonstrating them to others, though perhaps in not so vigorous a degree as I might desire.

I have lately made some other trials to render olive oil suitable for these experiments by heating it more rapidly. Although at present I

have no entirely reliable results, it seems to me that by heating ordinary olive oil to 80°—90° C. for twelve or twenty-four hours, a suitable medium may be obtained.

Finally, I would like to remark that I am the last person to defend the view that these drops, exhibiting protoplasma-like movements, are directly comparable to protoplasm. Composed as they are of oil, their substance is entirely different from protoplasm. They may be, however, compared with the latter, in my opinion, firstly with regard to their structure, and secondly with regard to their movements. But as the latter depend on the former, we may assume that the amœboid movement of protoplasm itself depends on a corresponding physical constitution.

These drops, too, resemble organisms inasmuch as they continue for days to exhibit movements, due to internal causes, which depend on their chemical and physical structure. I do not believe that up to this time any substance has been artificially prepared which, in these two points, viz., structure and movement, has so much resemblance to the most simple forms of life as have these reticulated drops. I hope, therefore, that my discovery will be a first step towards approaching the problem of life from the chemico-physical side, and towards passing from vague and general hypotheses of molecular constitution to the surer ground of concrete conceptions of a chemical and physical nature.

It is, however, a special satisfaction to me to hear that in your country, which has given rise to so many and so celebrated men in biological science, my investigations are followed with interest and sympathy.

With friendly greetings, I am yours sincerely,

O. Bütschli.

ARCHÆOLOGY AND ETHNOLOGY.

The Use of the Phonograph in the Study of the Languages of the American Indians.—At the meeting of the American Folk-Lore Society in Boston, on April 19th, Dr. J. Walter Fewkes read a paper on experiments which he had lately made with the phonograph in recording the songs, legends, and folk-lore of the Passamaquoddy Indians.

The necessity for some means of accurately recording and preserving the languages of the Indians has lately been met by the invention of the phonograph. This instrument has now been brought to such a